

I claim:

1. A multi-stroke fluid cylinder comprising:

- a) a head assembly having a fluid inlet for introducing fluid to the cylinder at a first pressure;
- b) a first positioning system including a plurality of pistons capable of moving a piston rod away from at least a portion of said first positioning system; and
- c) a second positioning system operatively positioned between said head assembly and said first positioning system for imparting movement of said first positioning system pistons to the piston rod, said second positioning system comprising:

a plurality of movable pistons for moving said piston rod a preselected distance;

at least one fluid supply member secured to a respective one of said pistons of said second positioning system for introducing a fluid between adjacent pistons of said second positioning system, wherein said fluid supply member extends within said first positioning system when said positioning systems are fully extended.

2. The multi-stroke cylinder according to claim 1 wherein said first positioning system includes a cylindrical housing containing said plurality of first positioning system pistons, said cylindrical housing having a plurality of openings in fluid communication with at least one recess in a respective one of said first positioning system pistons.
3. The multi-stroke cylinder according to claim 2 where said at least one recess in each said respective piston of said first positioning system includes at least one slot extending along a circumference of each said respective piston and a groove on a face of each of said respective piston for delivering fluid from said openings in said cylindrical housing to between adjacent pistons of said first positioning system.
4. The multi-stroke cylinder according to claim 2 wherein said cylindrical housing includes an inner wall and an outer wall; and each of said first positioning system pistons including a seal for engaging the inner wall of said cylindrical housing for preventing the passage of fluid therebetween.
5. The multi-stroke cylinder according to claim 2 wherein said second positioning system includes a cylinder containing said plurality of second positioning system pistons; and each said piston of said second positioning system includes a seal for engaging an inner surface of said second positioning system cylinder.

6. The multi-stroke cylinder according to claim 5 wherein at least a portion of said second positioning system cylinder extends within said cylindrical housing of said first positioning system.
7. The multi-stroke cylinder according to claim 6 wherein said second positioning system cylinder is concentric with said cylindrical housing of said first positioning system.
8. The multi-stroke cylinder according to claim 1 further including a stroke limiting member secured to said at least one fluid supply member; each stroke limiting member including a fluid inlet through which fluid can be introduced into a respective fluid supply member for moving at least one piston of said second positioning system pistons.
9. The multi-stroke cylinder according to claim 8 wherein said at least one fluid supply member includes a plurality of concentric tubular members.
10. The multi-stroke cylinder according to claim 8 wherein said at least one fluid supply member includes a plurality of concentrically positioned tubular members that each extend between a respective one of said stroke limiting members and a respective one of said second positioning system pistons so that each tubular member forms a fluid

channel between the fluid inlet of a respective one of said stroke limiting members and a respective one of said second positioning system pistons.

11. The multi-stroke cylinder according to claim 10 wherein said second positioning system pistons each include at least two parts secured to one another; and wherein a terminal end of a respective one of said tubular members is secured between said at least two parts of a respective second positioning system piston.
12. The multi-stroke cylinder according to claim 11 wherein said terminal end of each said tubular member is flared to fit between said at least two parts of said respective one of said second positioning system pistons.
13. The multi-stroke cylinder according to claim 12 wherein said stroke limiting members each have at least two parts between which the other terminal end of a respective one of said tubular members is secured.
14. The multi-stroke cylinder according to claim 1 wherein said head assembly includes a fluid transfer port through which fluid can be introduced within said second positioning system.

15. The multi-stroke cylinder according to claim 1 wherein said piston rod is attached to one of said pistons of said second positioning system adjacent said head assembly.
16. The multi-stroke cylinder according to claim 15 wherein said piston rod extends through said head assembly.
17. The multi-stroke cylinder according to claim 16 wherein at least one stroke limiting shaft is attached to the piston of said second positioning system adjacent said piston to which said piston rod is attached; and said at least one stroke limiting shaft extends through said piston to which the piston rod is secured.
18. The multi-stroke cylinder according to claim 17 wherein said piston rod includes a hollow internal bore and one end of said at least one stroke limiting shaft extends within said hollow bore.
19. The multi-stroke cylinder according to claim 1 wherein said first positioning system includes a plurality of rods contacting said second positioning system for imparting movement thereto.
20. The multi-stroke cylinder according to claim 1 wherein each of said pistons of said first positioning system are tethered to an adjacent piston of said first positioning

system so that adjacent pistons are capable of moving a predetermined distance relative to each other.

21. A multi-stroke fluid cylinder comprising:

- a) a first positioning system having a plurality of movable pistons for moving a positioning member a preselected distance;
- b) a second positioning system including:
  - i) a plurality of movable pistons for moving the positioning member a preselected distance;
  - ii) a plurality of fluid supply members each being secured to a respective one of said pistons of said second positioning system for introducing a fluid at a first pressure between adjacent pistons of said second positioning system; and
  - iii) a stroke limiting member secured to a terminal end of each of said fluid supply members;
- c) a head assembly including at least one fluid opening for communicating a fluid between one of said plurality of second positioning system pistons and said head assembly at a pressure lower than said first pressure.

22. The multi-stroke cylinder according to claim 21 wherein said first positioning system includes a cylindrical housing containing said plurality of first positioning system pistons, said cylindrical housing having a plurality of fluid openings, each said opening being in fluid communication with an opening in a respective one of said first positioning system pistons.
23. The multi-stroke cylinder according to claim 22 where said pistons of said first positioning system include at least one slot extending along each said piston in the direction of the movement of said pistons and a groove on a face of each of said pistons for delivering fluid from said fluid openings in said cylindrical housing to between adjacent pistons of said first positioning system.
24. The multi-stroke cylinder according to claim 22 wherein said cylindrical housing includes an inner wall and an outer wall; and each of said first positioning system pistons includes a seal for engaging the inner wall of said cylindrical housing for preventing the passage of fluid therebetween.
25. The multi-stroke cylinder according to claim 22 wherein said second positioning system includes a cylinder containing said plurality of second positioning system pistons, at least a portion of said second positioning system cylinder being positioned within said cylindrical housing of said first positioning system.

26. The multi-stroke cylinder according to claim 25 wherein each said piston of said second positioning system includes a seal for engaging an inner surface of said cylinder.
27. The multi-stroke cylinder according to claim 21 wherein each said stroke limiting member includes a fluid inlet through which fluid can be introduced into a respective one of said fluid supply members.
28. The multi-stroke cylinder according to claim 27 wherein said fluid supply members are concentric tubular members.
29. The multi-stroke cylinder according to claim 27 wherein said fluid supply members include a plurality of concentrically positioned tubular members that each extend between a respective one of said stroke limiting members and a respective one of said second positioning system pistons so that each tubular member forms a fluid channel between the fluid inlet of a respective one of said stroke limiting members and a respective one of said second positioning system pistons.
30. The multi-stroke cylinder according to claim 29 wherein said second positioning system pistons each include at least two parts secured to one another with a terminal



end of a respective one of said tubular members being secured between said at least two parts.

31. The multi-stroke cylinder according to claim 30 wherein each said terminal end is flared to fit between said at least two parts of a respective one of said second positioning system pistons.
32. The multi-stroke cylinder according to claim 31 wherein said stroke limiting members each have at least two parts; and each said tubular member includes a second terminal end secured between said at least two parts of a respective one of said stroke limiting members.
33. The multi-stroke cylinder according to claim 21 further including the positioning member, said positioning member having a piston rod attached to one of said pistons of said second positioning system adjacent said head assembly.
34. The multi-stroke cylinder according to claim 33 wherein said piston rod extends through said head assembly.
35. The multi-stroke cylinder according to claim 34 wherein one or more stroke limiting shafts are secured to the piston of said second positioning system adjacent said piston

to which said piston rod is attached; and said limiting shafts extend through said piston to which the piston rod is attached.

36. The multi-stroke cylinder according to claim 21 wherein said first positioning system includes a plurality of rods contacting said second positioning system for imparting movement thereto.
37. The multi-stroke cylinder according to claim 21 wherein said pistons of said first positioning system are each tethered to at least one immediately adjacent piston.
38. A multi-stroke fluid cylinder comprising:
  - a) a head assembly;
  - b) a first positioning system capable of moving a piston rod a preselected distance, said first positioning system comprising:
    - i) a rear plate adjacent a cylindrical housing, said housing having an inner wall and an outer wall, said cylindrical housing including a plurality of fluid inlets in said walls;
    - ii) a plurality of pistons positioned within said cylindrical housing;
    - iii) a plurality of said pistons including a fluid introduction opening for introducing a fluid between adjacent pistons, each said opening being in fluid communication with one of said fluid inlets in said cylindrical

housing, each of said pistons having a fluid introduction opening further including a seal for engaging the inner wall of said cylindrical housing for preventing fluid from passing between their respective pistons and the inner wall of said cylindrical housing; and

- c) said second positioning system including:
  - i) a cylinder having a plurality of pistons positioned there within, one of said pistons of said second positioning system having a face extending toward said head assembly and a face extending toward said rear plate;
  - ii) one of said plurality of pistons in said cylinder of said second positioning system including a member for cooperating with said first positioning system for imparting movement from the first positioning system to said head assembly; and
  - iii) at least one fluid supply member for introducing a fluid between adjacent pistons of said second positioning system, wherein said at least one supply member includes a first terminal end secured to a respective one of said pistons of said second positioning system and a second terminal end to which a stroke limiting member is attached for controlling the length of stroke of one of said pistons of said second positioning system.

39. The multi-stroke cylinder according to claim 38 wherein said first positioning system includes an inner cylindrical wall forming a central opening in the first positioning system; and each said piston of said first positioning system including a seal for engaging with a surface of said inner cylindrical wall.
40. The multi-stroke cylinder according to claim 39 wherein said at least one fluid supply member includes a concentric tubular member that extends through said central opening formed in said first positioning system.
41. The multi-stroke cylinder according to claim 39 wherein at least a portion of said second positioning system is located within said central opening of said first positioning system.
42. The multi-stroke cylinder according to claim 38 wherein said at least one fluid supply member includes a plurality of fluid supply members, each secured to a respective one of said pistons of said second positioning system and a respective stroke limiting member.
43. The multi-stroke cylinder according to claim 38 wherein each said piston of said second positioning system includes a seal for engaging an inner surface of said cylinder.

44. The multi-stroke cylinder according to claim 42 wherein each said stroke limiting member includes a fluid inlet through which fluid is introduced into a respective one of said fluid supply members.
45. The multi-stroke cylinder according to claim 44 wherein said fluid supply members are concentric tubular members.
46. The multi-stroke cylinder according to claim 42 wherein said second positioning system pistons include at least two parts secured to one another with said first terminal end of a respective fluid supply member being secured there between.
47. The multi-stroke cylinder according to claim 46 wherein said stroke limiting members each have at least two parts secured to one another with said second terminal end of a respective fluid supply member being secured there between.
48. The multi-stroke cylinder according to claim 38 wherein said head assembly includes a fluid transfer port.
49. The multi-stroke cylinder according to claim 38 further including a head assembly includes a tooling member attached to one of said pistons of said second positioning system adjacent said head assembly for moving a work piece.

50. The multi-stroke cylinder according to claim 49 wherein said tooling member includes a piston rod extending through said head assembly.
51. The multi-stroke cylinder according to claim 50 wherein one or more stroke limiting shafts are attached to the piston of said second positioning system adjacent said piston to which said piston rod is secured; and said limiting shafts extend through said piston to which the piston rod is secured.
52. A multi-stroke fluid cylinder comprising:
- a) a cylindrical housing having an inner wall and an outer wall;
  - b) a head assembly positioned proximate one end of said housing;
  - c) a positioning system comprising:
    - i) a plurality of movable pistons located within said housing for moving a piston rod a preselected distance; and
    - ii) a plurality of fluid supply members, each said fluid supply member being secured to a respective one of said pistons for introducing a fluid between adjacent pistons, wherein said fluid supply members are concentrically arranged and are at least partially coextensive with one another.

53. A multi-stroke fluid cylinder comprising:
- a head assembly including a positioning member;
  - a first positioning system having a housing including an outer surface and an inner surface forming a piston receiving area, a plurality of fluid openings extending through said housing for communicating a fluid from said outer surface to said inner surface, and a plurality of moveable pistons positioned within said piston receiving area for moving said positioning member;
  - a second positioning system including a housing and at least one moveable piston positioned therein for moving said positioning member; and
  - wherein at least a portion of said second positioning system housing is extends within said piston receiving area of said first positioning system housing.
54. The multi-stroke fluid cylinder according to Claim 53 wherein said pistons of said first positioning system include an opening in which said at least portion of said second positioning system is positioned.
55. The multi-stroke fluid cylinder according to claim 54 wherein said second positioning system housing includes a member for cooperating with said first positioning system to transfer the movement of the first positioning system to said positioning member.

56. The multi-stroke fluid cylinder according to Claim 53 wherein said at least one moveable piston of said second positioning system includes a plurality of moveable pistons.
57. The multi-stroke fluid cylinder according to claim 56 further includes a fluid conduit secured to at least one of said plurality of second positioning system pistons for providing fluid between said at least one of said plurality of pistons and an adjacent piston of said second positioning system.
58. The multi-stroke fluid cylinder according to claim 57 wherein said fluid conduit includes a stroke limiting member for preventing the piston secured to said conduit from moving said positioning member beyond a predetermined distance.
59. The multi-stroke fluid cylinder according to claim 58 wherein said stroke limiting member includes a fluid inlet for introducing within said conduit.
60. The multi-stroke fluid cylinder according to claim 53 wherein said pistons of said first and second positioning systems include seals for engaging with their respective housings.